

Ia'

wherein the R¹R²CH group in the 5-position of the cyclic parent structure and the hydroxy group in the 3-position of the cyclic parent structure are each in the trans position relative to each other and wherein the substituent R⁴ in the 4-position and the hydroxy group in the 3-position of the cyclic parent structure are each in the cis position relative to each other, and wherein n is 0 or 1,

R¹ is hydrogen; C₁-C₆-alkyl; or phenyl-C₁-C₆-alkyl optionally substituted one to three times in the phenyl ring by lower alkyl, lower haloalkyl, lower alkoxy or lower haloalkoxy, and

R² is hydrogen, or

R¹ and R² together are a double-bonded methylene group which may be substituted by C₁-C₅-alkyl or by phenyl-C₁-C₅-alkyl optionally substituted one to three times in the phenyl ring by lower alkyl, lower haloalkyl, lower alkoxy or lower haloalkoxy,

R³ is hydrogen, and

R⁴ is hydrogen; lower alkyl; or phenyl-lower alkyl optionally substituted one or more times in the phenyl ring by lower alkyl, lower haloalkyl, lower alkoxy or lower haloalkoxy, or

R³ and R⁴ also together are a C₂-alkylene chain; or a C₃-C₆-alkylene chain optionally containing 1 to 3 double bonds, which may be bridged by C₁-C₂-alkylene which is optionally substituted one or two times by lower alkyl,

R⁵ is hydrogen; lower alkyl; hydroxy; lower alkoxy; phenyl-lower alkoxy or phenyl-lower alkyl each of which may be optionally substituted one to three times in the phenyl ring by lower alkyl, lower haloalkyl, lower alkoxy or lower haloalkoxy, and

R⁶ is hydrogen, and

R⁷ is hydrogen, and

R⁸ is hydrogen;
cyano;

carboxy optionally esterified with cycloaliphatic or straight-chain or branched aliphatic C₁-C₆-alcohols optionally containing one to three double bonds, and optionally substituted one to three times by halogen or lower alkoxy, or alternatively esterified with phenyl-lower alcohols optionally substituted in the phenyl ring one to three times by lower alkyl, lower haloalkyl, lower alkoxy or lower haloalkoxy;

carbonylamino optionally substituted at the nitrogen once by C₃-C₈-cycloalkyl lower alkanoyl or straight-chain or branched aliphatic C₁-C₆-alkanoyl, which in each case are optionally substituted one to three times by halogen or lower alkoxy, or optionally substituted at the nitrogen once by phenyl-lower alkanoyl optionally substituted one to three times in the phenyl ring by lower alkyl, lower haloalkyl, lower alkoxy or lower haloalkoxy, or optionally substituted at the nitrogen one or two times by C₃-C₈-cycloalkyl-lower alkyl or straight-chain or branched aliphatic C₁-C₆-alkyl, which in each case are optionally substituted one to three times by halogen or lower alkoxy, or by phenyl-lower alkyl optionally substituted one to three times in the phenyl ring by lower alkyl, lower haloalkyl, lower alkoxy or lower haloalkoxy;

carbonylamino substituted at the nitrogen with a

suitable amino protecting group;

a monocyclic or bicyclic ring system with 3 to 10 ring carbon atoms which is optionally unsaturated one to four times, the ring carbon atoms of said ring system optionally being replaced one to three times by nitrogen, oxygen and/or sulfur and which ring system may be substituted one to three times by lower alkyl, lower haloalkyl, lower alkoxy, hydroxy, halogen or by a lower alkylene chain which is bonded to two oxygen atoms bonded to adjacent carbon atoms of the ring system;

a straight-chain or branched C₁-C₁₂-alkyl group optionally containing one to three double bonds, which may optionally be substituted one to three times by

halogen,

hydroxy,

lower alkoxy,

carboxy optionally esterified with cycloaliphatic or straight-chain or branched aliphatic C₁-C₆-alcohols, which optionally contain one to three double bonds, and which are optionally substituted one to three times by halogen or lower alkoxy,

carboxy esterified with phenyl-lower alcohols optionally substituted in the phenyl ring one to three times by lower alkyl, lower haloalkyl, lower alkoxy or lower haloalkoxy;

cyano,

mercapto,

lower alkylthio,

amino,

lower alkylamino,

carbonylamino optionally substituted once at the nitrogen by C₃-C₈-cycloalkyl-lower alkanoyl or straight-chain or branched aliphatic C₁-C₆-alkanoyl,

haloalkoxy, hydroxy, halogen or by a lower alkylene chain which is bonded to two oxygen atoms bonded to adjacent carbon atoms of the ring system, or

R⁶ and R⁷ also together may form a bond, and

R⁵ and R⁸, together with the carbon atoms to which they are bonded, may form an aromatic C₆-ring system which may be fused with 2 to 4 further carbon atoms to form a bicyclic ring system having a total of 3 to 5 double bonds which contains a total of 8 to 10 ring carbon atoms, wherein the carbon atoms of this C₆- to C₁₀-ring system which do not bear the substituents R⁵ or R⁸ may be replaced one to three times independently by sulfur, oxygen or nitrogen, and wherein this C₆- to C₁₀-ring system may optionally be substituted one to three times by lower alkyl, lower haloalkyl, lower alkoxy, lower haloalkoxy, hydroxy, halogen or by a lower alkylene chain which is bonded to two oxygen atoms bonded to adjacent carbon atoms of the ring system,

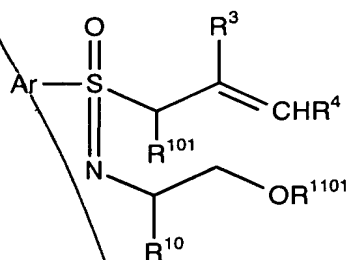
R⁹ is hydrogen; lower alkyl; phenyl-lower alkyl optionally substituted one to three times in the phenyl ring by lower alkyl, lower haloalkyl, lower alkoxy or lower haloalkoxy; or an amino protecting group, or

R⁸ and R⁹ also together may form a C₃-C₄-alkylene chain,

or an acid addition salt thereof, wherein any reactive groups which may be present in said compound of Formula Ia' may be blocked by suitable protecting groups,

said process comprising the steps of:

a) reacting a compound corresponding to formula II:



II

wherein

R³ and R⁴ have the above meanings,

R¹⁰¹ has the meaning given above for R¹ with the exception of an optionally substituted methylene group,

Ar represents phenyl optionally substituted one to three times by lower alkyl,

R¹⁰ is lower alkyl, or phenyl optionally substituted once in the phenyl ring by lower alkyl or by hydroxy protected with a suitable protecting group, or phenyl-lower alkyl optionally substituted once in the phenyl ring by lower alkyl, and

R¹¹⁰¹ stands for a silyl protecting group,

successively with

(i) a base suitable for the deprotonation thereof,

(ii) an organometallic reagent corresponding to the

formula VII:



VII

wherein

X is halogen,

M² is a tetravalent transition metal, and

R¹² is lower alkyl, phenyl or phenyl-lower alkyl, and

(iii) a stereoisomer of a compound of the general formula

VIII:



R^5, R^6, R^7 and n have the above meanings,

R⁹⁰¹ is hydrogen or together with R⁸⁰¹ forms a C₃-C₄-alkylene chain, and

R¹³ is an amino protecting group which when cleaved leaves behind a nitrogen nucleophile,

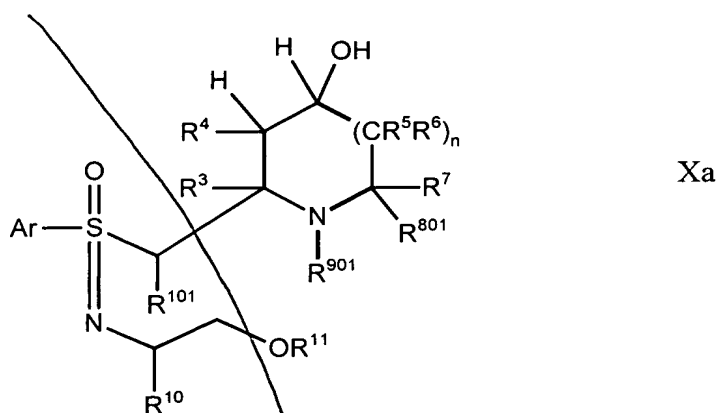
to form a stereoisomer of a compound corresponding to the formula IX:



$R^{101}, R^3, R^4, R^5, R^6, R^7, R^{801}, R^{901}, R^{10}, R^{1101}, R^{12}, R^{13},$
 n, Ar and M^2 have the above meanings,

and

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wherein

R^{101} , R^3 , R^4 , R^5 , R^6 , R^7 , R^{801} , R^{901} , R^{10} , n and Ar have the above meanings, and

R¹¹ is hydrogen or a silyl protecting group,

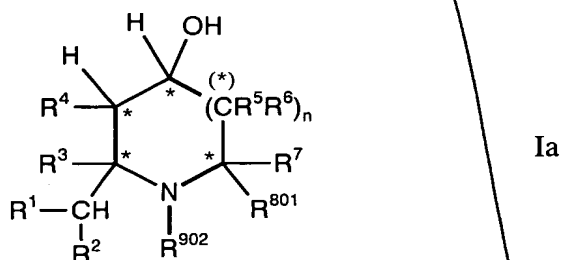
and

if R⁹⁰¹ is hydrogen, blocking the nitrogen atom in the cyclic parent structure of the resulting compound of Formula Xa with a base-stable protecting group, and

cleaving off any silyl protecting group R^{11} which may still be present;

and

c) for the production of a compound corresponding to formula Ia:



wherein

$R^1, R^2, R^3, R^4, R^5, R^6, R^7, R^{801}$ and n have the above

stands for a base-stable protecting group or a C₃-C₄-alkylene chain,

reacting a compound corresponding to formula Ia or a compound produced by cleaving the protecting group R¹¹ with a reagent effecting the reductive cleavage of the sulfonyl bond, in order to obtain a compound corresponding to formula Ib:

Ib

where R³, R⁴, R⁵, R⁶, R⁷, R⁸⁰¹, R⁹⁰² and R¹⁰¹ are as defined above,

in a resulting compound of Formula Ia, if R¹⁰¹ is other than hydrogen, effecting the cleavage of the sulfonyl bond by activating the sulfonyl-alkyl bond under the action of a base-induced elimination, in order to obtain a compound corresponding to formula Ic:

Ic

stands for a base-stable protecting group or a C₃-C₄-alkylene chain,

reacting a compound corresponding to formula Ia or a compound produced by cleaving the protecting group R¹¹ with a reagent effecting the reductive cleavage of the sulfonyl bond, in order to obtain a compound corresponding to formula Ib:

Ib

where R³, R⁴, R⁵, R⁶, R⁷, R⁸⁰¹, R⁹⁰² and R¹⁰¹ are as defined above,

in a resulting compound of Formula Ia, if R¹⁰¹ is other than hydrogen, effecting the cleavage of the sulfonyl bond by activating the sulfonyl-alkyl bond under the action of a base-induced elimination, in order to obtain a compound corresponding to formula Ic:

Ic

stands for a base-stable protecting group or a C₃-C₄-alkylene chain,

reacting a compound corresponding to formula Ia or a compound produced by cleaving the protecting group R¹¹ with a reagent effecting the reductive cleavage of the sulfonyl bond, in order to obtain a compound corresponding to formula Ib:

Ib

where R³, R⁴, R⁵, R⁶, R⁷, R⁸⁰¹, R⁹⁰² and R¹⁰¹ are as defined above,

in a resulting compound of Formula Ia, if R¹⁰¹ is other than hydrogen, effecting the cleavage of the sulfonyl bond by activating the sulfonyl-alkyl bond under the action of a base-induced elimination, in order to obtain a compound corresponding to formula Ic:

Ic



stands for a base-stable protecting group or a C₃-C₄-alkylene chain,

reacting a compound corresponding to formula Ia or a compound produced by cleaving the protecting group R¹¹ with a reagent effecting the reductive cleavage of the sulfonyl bond, in order to obtain a compound corresponding to formula Ib:

Ib

where R³, R⁴, R⁵, R⁶, R⁷, R⁸⁰¹, R⁹⁰² and R¹⁰¹ are as defined above,

in a resulting compound of Formula Ia, if R¹⁰¹ is other than hydrogen, effecting the cleavage of the sulfonyl bond by activating the sulfonyl-alkyl bond under the action of a base-induced elimination, in order to obtain a compound corresponding to formula Ic:

Ic

stands for a base-stable protecting group or a C₃-C₄-alkylene chain,

reacting a compound corresponding to formula Ia or a compound produced by cleaving the protecting group R¹¹ with a reagent effecting the reductive cleavage of the sulfonyl bond, in order to obtain a compound corresponding to formula Ib:

Ib

where R³, R⁴, R⁵, R⁶, R⁷, R⁸⁰¹, R⁹⁰² and R¹⁰¹ are as defined above,

in a resulting compound of Formula Ia, if R¹⁰¹ is other than hydrogen, effecting the cleavage of the sulfonyl bond by activating the sulfonyl-alkyl bond under the action of a base-induced elimination, in order to obtain a compound corresponding to formula Ic:

Ic

stands for a base-stable protecting group or a C₃-C₄-alkylene chain,

reacting a compound corresponding to formula Ia or a compound produced by cleaving the protecting group R¹¹ with a reagent effecting the reductive cleavage of the sulfonyl bond, in order to obtain a compound corresponding to formula Ib:

Ib

where R³, R⁴, R⁵, R⁶, R⁷, R⁸⁰¹, R⁹⁰² and R¹⁰¹ are as defined above,

in a resulting compound of Formula Ia, if R¹⁰¹ is other than hydrogen, effecting the cleavage of the sulfonyl bond by activating the sulfonyl-alkyl bond under the action of a base-induced elimination, in order to obtain a compound corresponding to formula Ic:

Ic



wherein

R³, R⁴, R⁵, R⁶, R⁷, R⁸⁰¹, R⁹⁰² and n have the above meanings, and

R¹⁰² stands for C₁-C₅-alkyl or for phenyl-lower alkyl optionally substituted one or more times in the phenyl ring by lower alkyl, lower haloalkyl, lower alkoxy or lower haloalkoxy, the lower alkylene chain of which phenyl-lower alkyl may contain 1 to 5 carbon atoms,

and

if desired, cleaving off any protecting groups in compounds of Formula Ia,

and

if desired, reacting the optionally released NH group in the 1-position of the cyclic parent structure with a reagent capable of N-alkylation or a reagent capable of amide formation or blocking the released NH group with an amino protecting group,

thereby obtaining said compound corresponding to Formula Ia'.

18. A process according to claim 17, for producing a compound corresponding to formula Ib, said process comprising the steps of

(a) cleaving any protecting groups which may be present, and

(b) reacting any free NH group in the 1-position of the cyclic parent structure with

(i) a reagent capable of N-alkylation, or

(ii) a reagent capable of amide formation, or

(iii) a reagent which blocks the free NH group with an amino protecting group.

19. A process according to claim 17, wherein R^{13} in the compound of Formula VIII is a base-labile amino protecting group, and wherein the protecting group R^{13} is removed in step b) by treatment with a base reagent.

Sub C2
20. A process according to claim 19, wherein said base-labile amino protecting group is a fluoren-9-yl-methyloxy-carbonyl radical.

21. A process according to claim 20, wherein the base reagent comprises piperidine.

22. A process according to claim 17, wherein toluene is used as a solvent in step a).

Sub B3
23. A process according to claim 17, wherein in step ca), the sulfonimidoyl-alkyl bond in the compound corresponding to formula Xa is reductively cleaved with samarium (II) iodide.

24. A process according to claim 17, wherein R^4 is other than hydrogen in each of the compounds corresponding to formulas Ia', Ia, Ib, Ic, II, IX and Xa.

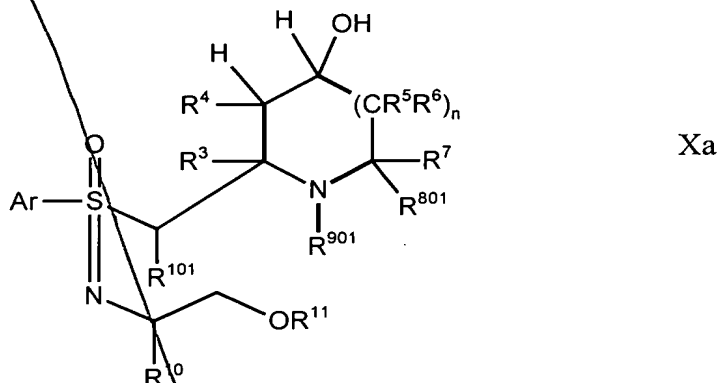
25. A process according to claim 17, wherein R^{1101} is a tert. butyl-dimethylsilyl protecting group or a trimethylsilyl protecting group.

26. A process according to claim 17, wherein R^8 is hydrogen, lower alkyl, phenyl, phenyl-lower alkyl or lower-alkoxy lower alkyl, or

R^6 and R^7 together form a bond and R^5 and R^8 , together with the carbon atoms to which they are bonded, form an aromatic C_6 -ring system, or

R^8 together with R^9 forms a C_3 - C_4 -alkylene chain.

27. A compound corresponding to formula Xa:



wherein

n is 0 or 1,

R^3 is hydrogen, and

~~R⁴ is hydrogen; lower alkyl; or phenyl-lower alkyl optionally substituted one or more times in the phenyl ring by lower alkyl, lower haloalkyl, lower alkoxy or lower haloalkoxy, or~~

~~R³ and R⁴ also together are a C₂-alkylene chain; or a C₃-C₆-alkylene chain optionally containing 1 to 3 double bonds, which may be bridged by C₁-C₂-alkylene which is optionally substituted one or two times by lower alkyl.~~

R⁵ is hydrogen; lower alkyl; hydroxy; lower alkoxy; phenyl-lower alkoxy or phenyl-lower alkyl each of which may be optionally substituted one to three times in the phenyl ring by lower alkyl, lower haloalkyl, lower alkoxy or lower haloalkoxy, and

R^6 is hydrogen, and

R⁷ is hydrogen,

R¹⁰ is lower alkyl, or phenyl optionally substituted once in the phenyl ring by lower alkyl or by hydroxy protected with a suitable protecting group, or phenyl-lower alkyl optionally substituted once in the phenyl ring by lower alkyl,

~~R¹⁰¹ is hydrogen; C₁-C₆-alkyl; or phenyl-C₁-C₆-alkyl optionally substituted one to three times in the phenyl ring by aralkyl, lower haloalkyl, lower alkoxy or lower haloalkoxy,~~

carboxy optionally esterified with cycloaliphatic or straight-chain or branched aliphatic C₁-C₆-alcohols optionally containing one to three double bonds, and optionally substituted one to three times by halogen or lower alkoxy, or alternatively esterified with phenyl-lower alcohols optionally substituted in the phenyl ring one to three times by lower alkyl, lower haloalkyl, lower alkoxy or lower haloalkoxy;

carbonylamino optionally substituted at the nitrogen once by C₃-C₈-cycloalkyl lower alkanoyl or straight-chain or branched aliphatic C₁-C₆-alkanoyl, which in each case are optionally substituted one to three times by halogen or lower alkoxy, or optionally substituted at the nitrogen once by phenyl-lower alkanoyl optionally substituted one to three times in the phenyl ring by lower alkyl, lower haloalkyl, lower alkoxy or lower haloalkoxy, or optionally substituted at the nitrogen one or two times by C₃-C₈-cycloalkyl-lower alkyl or straight-chain or branched aliphatic C₁-C₆-alkyl, which in each case are optionally substituted one to three times by halogen or lower alkoxy, or by phenyl-lower alkyl optionally substituted one to three times in the phenyl ring by lower alkyl, lower haloalkyl, lower alkoxy or lower haloalkoxy;

carbonylamino substituted at the nitrogen with a suitable amino protecting group;

a monocyclic or bicyclic ring system with 3 to 10 ring carbon atoms which is optionally unsaturated one to four

a straight-chain or branched C₁-C₁₂-alkyl group optionally containing one to three double bonds, which may optionally be substituted one to three times by

carboxy optionally esterified with cycloaliphatic or straight-chain or branched aliphatic C₁-C₆-alcohols, which optionally contain one to three double bonds, and which are optionally substituted one to three times by halogen or lower alkoxy,

carboxy esterified with phenyl-lower alcohols optionally substituted in the phenyl ring one to three times by lower alkyl, lower haloalkyl, lower alkoxy or lower haloalkoxy;

cyano,
mercapto,
lower alkylthio,
amino,
lower alkylamino,

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alkanoyl optionally substituted one to three times in the phenyl ring by lower alkyl, lower haloalkyl, lower alkoxy or lower haloalkoxy,

carbonylamino substituted once or twice at the nitrogen by C₃-C₈-cycloalkyl-lower alkyl or straight-chain or branched aliphatic C₁-C₆-alkyl, which are each optionally substituted one to three times by halogen or lower alkoxy, or by phenyl-lower alkyl optionally substituted one to three times in the phenyl ring by lower alkyl, lower haloalkyl, lower alkoxy or lower haloalkoxy,

carbonylamino substituted at the nitrogen with a suitable amino protecting group,

a monocyclic or bicyclic ring system with 3 to 10 ring carbon atoms which is optionally unsaturated one to four times, the ring carbon atoms of which may be replaced one to three times by nitrogen, oxygen and/or sulfur and which ring system may be substituted one to three times by lower alkyl, lower haloalkyl, lower alkoxy, hydroxy, halogen or by a lower alkylene chain which is bonded to two oxygen atoms bonded to adjacent carbon atoms of the ring system, or

R⁵ and R⁸⁰¹ also, together with the carbon atoms to which they are bonded, may form a monocyclic or bicyclic ring system with 5 to 10 ring carbon atoms which optionally contains 1 to 3 double bonds, wherein carbon atoms not bearing the substituents R⁵ or R⁸⁰¹ optionally may be replaced one to three times independently by sulfur, oxygen or nitrogen, and which optionally may be substituted one to three times by lower alkyl, lower haloalkyl, lower alkoxy, lower haloalkoxy, hydroxy, halogen or by a lower alkylene chain which is bonded to two oxygen atoms bonded to adjacent carbon atoms of the ring system, or

R⁶ and R⁷ also together may form a bond, and

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R⁵ and R⁸⁰¹, together with the carbon atoms to which they are bonded, may form an aromatic C₆-ring system which may be fused with 2 to 4 further carbon atoms to form a bicyclic ring system having a total of 3 to 5 double bonds which contains a total of 8 to 10 ring carbon atoms, wherein the carbon atoms of this C₆- to C₁₀-ring system which do not bear the substituents R⁵ or R⁸⁰¹ may be replaced one to three times independently by sulfur, oxygen or nitrogen, and wherein this C₆- to C₁₀-ring system may optionally be substituted one to three times by lower alkyl, lower haloalkyl, lower alkoxy, lower haloalkoxy, hydroxy, halogen or by a lower alkylene chain which is bonded to two oxygen atoms bonded to adjacent carbon atoms of the ring system, and wherein any reactive groups in R⁸⁰¹ are blocked by base-stable protecting groups,

R⁹⁰¹ is hydrogen or together with R⁸⁰¹ forms a C₃-C₄-alkylene chain, and

Ar represents phenyl optionally substituted one to three times by lower alkyl,

wherein the sulfur-containing substituent in the 5-position and the hydroxy group in the 3-position of the cyclic parent structure are in the trans position relative to each other, and

wherein the substituent R⁴ in the 4-position and the hydroxy group in the 3-position of the cyclic parent structure are in the cis position relative to each other, or

a compound obtainable by removal of any protecting groups which may be present in said compound corresponding to formula Xa, or

an acid addition salt formed with a free amino group which may be present in said compound corresponding to formula Xa.

28. A compound according to claim 27, wherein the cyclic structure of formula Xa contains a secondary nitrogen atom protected by a tert. butoxycarbonyl protecting group.

B5 29. A compound according to claim 28, wherein R⁸⁰¹ and R⁹⁰¹ together form a C₃-C₄-alkylene chain.

30. A compound according to claim 27, wherein R⁸⁰¹ is hydrogen, lower alkyl, phenyl, phenyl-lower alkyl or lower-alkoxy lower alkyl, or

R⁶ and R⁷ together form a bond and R⁵ and R⁸⁰¹, together with the carbon atoms to which they are bonded, form an aromatic C₆-ring system, or

R⁸⁰¹ together with R⁹⁰¹ forms a C₃-C₄-alkylene chain.

31. A method of reductive desulfurisation of an alkyl-sulfonimidoyl compound corresponding to formula Xa of claim 17, wherein R³, R⁴, R⁵, R⁶, R⁷, R¹⁰, R¹¹, R¹⁰¹, R⁸⁰¹, R⁹⁰¹ and Ar have the meanings given in claim 17, said method comprising reducing said alkyl-sulfonimidoyl compound with samarium (II) iodide.

32. A process for stereochemically controlled production of an azacyclic compound according to claim 17, wherein the compound of formula II is produced from a compound selected from the group consisting of (R_S)-4(S)-isopropyl-2-p-toluoyl-4,5-dihydro[1,2λ⁶,3]oxathiazol-2-oxide, (S_S)-4(S)-isopropyl-2-p-toluoyl-4,5-dihydro[1,2λ⁶,3]oxathiazol-2-oxide, (R_S)-4(R)-isopropyl-2-p-toluoyl-4,5-dihydro[1,2λ⁶,3]oxa-thiazol-2-oxide, and (S_S)-4(R)-isopropyl-2-p-toluoyl-4,5-dihydro[1,2λ⁶,3]-oxathiazol-2-oxide.

33. A process for stereochemically controlled production of an azacyclic compound according to claim 17, wherein the compound of formula II is produced from [S_S,N(1S)]-N-[1-[[tert.-butyldimethylsilyl)-oxy]methyl]-2-methylpropyl]-S-methyl-S-(4-methylphenyl)-sulfoximide or [R_S,N(1R)]-N-[1-[[tert.-butyldimethylsilyl)oxy]-methyl]-2-methylpropyl]-S-methyl-S-(4-methylphenyl)sulfoximide.